Cross sectoral FDI spillovers and their impact on manufacturing productivity

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CROSS SECTORAL FDI SPILLOVERS AND THEIR IMPACT ON MANUFACTURING PRODUCTIVITY

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ABSTRACT

This paper explores the relationship between FDI spillovers and productivity in manufacturing firms in five European transition countries. The novelty of our approach lies in separating the impact of vertical linkages from services and manufacturing sectors. For this purpose, we rely on firm level data obtained from the Amadeus database and annual input-output tables. The results from a dynamic panel model reveal that local manufacturing firms benefit from the presence of foreign firms in upstream services, especially in the knowledge intensive services, and in downstream manufacturing sector while the effect of intra-industry spillovers and manufacturing forward linkages are negative. The firms' productivity is also influenced positively by human capital and intangible assets. The results for intra-industry spillovers suggest attenuating effects for higher levels of firms' absorptive capacity in some countries.

Keywords: FDI, services, vertical linkages, productivity spillovers
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1. INTRODUCTION

FDI is often recognised as a catalyst for economic development; hence countries of Central and Eastern Europe have put considerable effort in attracting FDI through various financial, fiscal and other incentives (OECD, 2005; Jindra and Rojec, 2014). The investment policies and various incentives offered to multinational corporations (MNCs) are based on the premise that FDI makes important contributions to economic development through either voluntary or involuntary knowledge transfer to local firms within and across industries, resulting in productivity improvements (Caves, 1974; Markusen and Venables, 1999; Blomström and Kokko, 2001; Javorcik, 2004; Hallin and Holmstrom-Lind, 2012). However, the empirical evidence has been rather inconclusive, with the estimated impact varying from mostly positive in case of backward linkages to insignificant or even negative in case of horizontal and forward spillovers (Görg and Greenaway, 2004; Havránek and Iršová, 2011; Iršová and Havránek, 2013). Several reasons have been put forward to explain this ambiguity such as the measurement of FDI spillovers (Ben Hamida and Gugler, 2009; Barbosa and Eiriz, 2009; Barrios et al., 2011; Driffield and Jindra, 2012), methodological issues (Görg and Strobl, 2001), heterogeneity of domestic and foreign firms (Blalock and Simon, 2009, Damijan et al., 2013: Javorcik and Spatareanu, 2011; Ha and Giroud, 2015), the inability to disentangle unintentional knowledge spillovers from intentional knowledge diffusion (Smeets, 2008), and competition effects (Garcia et al., 2013).

Despite the broad consensus that the growth of services is a crucial determinant of economic growth and development of other sectors (Francois, 1990; Eschenbach and Hoekman, 2006) and the increasing role of services in economic output, employment and production processes at different levels of the value chain (Hoekman and Mattoo, 2008; UNCTAD, 2008), spillovers from service sector firms to manufacturing clients and suppliers have been, with few exceptions, neglected (e.g. Miozzo and Grimshaw, 2008; Miozzo et al., 2012; Arnold et al., 2011; Fernandes and Paunov, 2012; Mariotti et al., 2013; Mariotti et al., 2015). FDI in services now account for almost 65 per cent of total worldwide inward FDI stock (UNCTAD, 2014). Similar trends can also be observed in new EU member states where the bulk of new investment is concentrated in services (Eurostat data, online data code: bop_fdi_pos).

There are several reasons why FDI in services may have beneficial effects on domestic firms' productivity. First, it is assumed that MNCs bring advanced technology, know-how and other skills which may spill over to local economy if they are not able to fully internalize the market for technology (Griliches, 1992). Second, services are also direct inputs in the production function (Antonelli, 1999) and determine the productivity of factors of production, thus acting as a strong determinant of the competitiveness, innovation and growth (Guerrieri et al., 2005; Hoekman and Mattoo, 2008; François and Worz, 2008). Thirdly, services (particularly KIBS) may have positive spillover effects on other industries (UNCTAD, 2004; Kox and Rubalcaba, 2007; Camacho and Rodriguez, 2007; Arnold et al., 2011; Mariotti et al. 2013; Mariotti et al., 2015).

CEE countries offer an interesting case for the analysis of FDI spillovers due to the recent increase in FDI in services that is particularly relevant for increased efficiency, competition and quality of their service sector which played a minor role under socialism (Gabrisch and Hölscher 2006). In the first decade of transition, foreign service providers undertook mainly horizontal demand-led investments (Hardy et al., 2011) that generally involved joint ventures or takeovers of domestic firms in order to draw on domestic firms' expertise and access to their clients (Dicken, 2003; Dossani and Kenney, 2007). However, with increased fragmentation and reallocation of production activities, many Western MNCs have moved their service operations to Central Europe to achieve cost efficiencies (Sass, 2008). These countries emerged as locations for outsourcing of specific business functions as well as offshoring of corporate business functions (Fillipov and Kalotay, 2009). Furthermore, governments of these countries invested significant resources in attracting MNCs (Jindra and Majec, 2014). However, to date there has been no investigation of the potential benefits of FDI in services on the productivity of downstream manufacturing firms in these countries. Hence, this study aims to inform policy makers about productivity implications of FDI so that they can identify the industries that provide the highest potential for technology spillovers and adjust their investment incentives accordingly.

We contribute to the existing literature in several ways. First, we pursue the idea that prevailing measurement of vertical linkages does not allow proper identification of entire spillover benefits as it fails to differentiate between the channels through which spillovers occur. This is, to our best knowledge, the first study that investigates the spillover effects of foreign firms on the total factor productivity of local manufacturing firms using five measures of FDI spillovers, one measuring horizontal spillovers and four measuring vertical spillovers, two related to backward linkages and two to forward linkages arising from manufacturing and service sectors. This will enable us to shed more light on the customer supplier relationship between domestic and foreign firms in two main sectors of economy. Second, drawing on the notion of absorptive capacity (Cohen and Levinthal, 1990; George and Zahra, 2002; Narula and Marin, 2003), which highlights the ability of local firms to absorb the external knowledge (Blalock and Simon, 2009; Sanchez-Sellero et al., 2014), we evaluate the moderating role of domestic firms' investment in intangible assets. Third, we investigate the heterogeneity of forward linkages in services which depends on the knowledge intensity of the service sector.

The analysis is based on firm level data in five transition economies (the Czech Republic, Estonia, Hungary, Slovakia and Slovenia) for the period between 2002 and 2010. Unlike other empirical studies, we use annual input-output tables for the calculation of spillover measures thus relaxing the restrictive assumption of stable customer-supplier relationships at industry level. Our empirical strategy is based on a two-stage approach. In the first stage, we estimate the firms' total factor productivity (TFP) using a semi-parametric method. In the second stage we explore productivity spillovers using a dynamic model that tackles the problem of endogeneity.

The paper begins with a review of the literature on the impact of FDI spillovers on the host country firms with special emphasis on FDI in services. The empirical strategy section describes the variables and data together with the methodology and presents the baseline empirical model. The subsequent section details empirical findings and discusses the results of alternative model specifications. The last section contains concluding remarks including policy implications and suggestions for further research.

2. MNCs AND POTENTIAL SPILLOVERS

2.1 INTRA- AND INTER-INDUSTRY SPILLOVERS

The most common assumption in FDI theory and new trade theory is that MNCs are the most productive firms and possess specific advantages that enable them to reap the benefits of operating in foreign countries and transfer technology across borders (Dunning and Lundan, 2008; Helpman et al., 2004; Antras and Yeaple, 2013). Given the technological sophistication of MNCs and their productivity advantage, a large strand of literature has developed to explain how FDI spillovers occur.[1] Horizontal spillovers occur mainly through unintentional knowledge diffusion due to market failure (non-excludable and non-rival nature of knowledge) and therefore constitute an externality (Arrow, 1962; Hallin and Holmstrom-Lind, 2012). There are a number of explanations for this unintentional knowledge diffusion. There are demonstration effects occurring through imitation and reverse engineering of MNCs' know-how, the knowledge of production techniques and organizational and marketing practices which depend on the extent of foreign presence in the industry (Kouizumi and Kopecky, 1977; Findlay, 1978). Other studies maintain that knowledge spillovers is the outcome of worker mobility (Fosfuri et al., 2001; Glass and Saggi, 2002; Markusen and Trofimenko, 2009). Local firms can benefit from employees previously working in MNCs as the latter is likely to provide host country workforce with a higher degree of training, education and valuable working experience (Smeets, 2008). Another strand of literature emphasizes the endogenous nature of spillovers generated by technological competition between foreign and local firms (Wang and Blomström, 1992). Increased competition puts pressure on domestic firms to introduce stricter or more cost conscious management, develop new technology and encourage more efficient allocation of resources resulting in increased productivity (Blomström and Kokko, 1998).

However, the extent and magnitude of horizontal spillovers depends on firms' absorptive capacity which enables local firms to evaluate and use external knowledge (Zanfei, 2012)

[1] In the empirical estimation of FDI productivity spillovers researchers are not able to separate the effects of knowledge spillovers and intentional knowledge transfer (Smeets, 2008). The standard sector level measures based on input-output tables used in the literature focus on the extent of demand for intermediate inputs. Spillovers from vertical linkages and corresponding productivity improvements will then occur either through voluntary knowledge transfer or through externalities in the form of increased demand for intermediate inputs (Giroud, 2012; Newman et al. 2015). Only few studies were able to separate the direct effects of linkages and voluntary knowledge transfer from externalities (Newman et al., 2015).

as well as pace and regularity of foreign entry (Wang et al., 2012). At the same time, foreign firms pay higher wages and offer other benefits, thus raising labour costs for local firms who want to keep their most valuable employees (Spencer, 2008). Finally, increased competition puts downward pressure on prices leading to lower profitability. Taken together, these mechanisms suggest that foreign entry may lead to crowding out of local firms (Aitken and Harrison, 1999).

Empirical studies find the effect of FDI horizontal spillovers on productivity of domestic firms to be mostly insignificant or even negative in developing countries (Kugler, 2006; Liu, 2008; Wooster and Diebel, 2010; Hale and Long, 2011; Xu and Sheng, 2012) and transition economies (Djankov and Hoekman, 2000; Konings, 2001; Kolasa, 2008: Gersl et al., 2008; Damijan et al., 2013). The picture is more optimistic for industrialized countries where horizontal spillovers are found to be mostly positive (Haskel et al., 2007; Karpaty and Lundberg, 2004; Keller and Yeaple, 2009; Belderbos and Van Roy, 2010). As emphasized by Ben Hamida and Gugler (2009), the ambiguity of empirical results is closely related to inability of theoretical models to provide a complete picture of diverse channels and mechanisms through which technology is transmitted. In addition, the type of knowledge also matters as codified knowledge can be easily transferred and repeated while tacit knowledge is difficult to imitate. Contradictory findings may also result from the heterogeneity of foreign firms (Castellani and Zanfei, 2007) such as geographical origin (Buckley et al., 2007; Javorcik and Spatareanu, 2011), level of foreign ownership (Javorcik and Spatareanu, 2008) and the mode of entry (Stancik, 2009; Balswick and Haller, 2011).

With the above discussion in mind, this paper aims to test the following hypotheses:

H1a: The presence of MNCs in manufacturing is positively related to the productivity of manufacturing firms in the same sector

H1b: The presence of MNCs in manufacturing is negatively related to the productivity of domestic manufacturing firms in the same sector

We expect *H1a* will hold if the positive demonstration effect prevails over the negative competition effect and *H1b* will hold for the opposite case, i.e., if MNCs exploit their superior technology and market power to force local competitors to reduce their output.

Given the limited scope for horizontal spillovers, scholars argue that spillovers are more likely to arise through direct knowledge transfer and pecuniary externalities as MNCs have an incentive to minimize technological leakages to their direct competitors but have strong incentives to improve the productivity of their suppliers (Alfaro and Rodriguez, 2004: Javorcik, 2004). MNCs have much to gain from improved input quality as it strengthens their competitive position in global markets (Alcacer and Oxley, 2014). By engaging in cooperation with MNCs, domestic suppliers are expected to benefit from inter-firm exchange of technical and managerial knowledge, technical assistance on product design, quality control and inventory management as well as financial and procurement assistance (Giroud, 2007; Zanfei, 2012). Customers of MNCs can also benefit from spillovers and knowledge embodied in products, processes and technologies as well as improved access to enhanced or previously unavailable inputs and products (Jindra et al., 2009). Apart from technology spillovers, domestic firms may also benefit from pecuniary externalities as the entry of foreign firms increases competition thus reducing concentration and lowering input prices (Rodriguez-Clare, 1996; Markusen, and Venables, 1999). Pecuniary externalities may have even larger beneficial effects since they are available to a large number of firms, some of them not involved in vertical linkages with MNCs (Castellani, 2012).[2]

Existing empirical studies suggest that the most likely channel for productivity improvement of domestic suppliers is through backward linkages in the manufacturing sector, rather than through demonstration/imitation or forward linkages (Javorcik, 2004; Blalock and Gertler, 2008; Havránek and Iršová, 2011; Damijan et al., 2013). However, most empirical studies fail to disentangle the effects of vertical linkage stemming from manufacturing and services MNCs and mostly focus either on backward (Blalock and Gertler, 2008; Damijan et al., 2013; Merlevede et al., 2014) or forward linkages (Arnold et al., 2011, Fernandes and Paunov, 2012). Only a few studies investigate the effects of both linkages but only among manufacturing FDI (Javorcik, 2004; Kolasa, 2008; Gersl et al., 2008; Nicolini and Resmini, 2010), ignoring the impact of FDI in services. The above discussion points to a further hypothesis about linkages which is tested in this paper:

H2: The presence of MNCs in downstream manufacturing sectors creates positive spillovers to domestic manufacturing suppliers

[2] However, fewer benefit may arise if backward linkages are formed in protected industries in which there are inadequate incentives to invest upgrading technology (UNCTAD, 2001) or when MNCs acts as monopsony enforcing unfair terms and conditions on their suppliers (Ivarsson and Alvstam, 2005).

H3: The presence of MNCs in upstream manufacturing sectors creates positive spillovers to domestic manufacturing clients

2.2 Linkages in the Service Sector

There are several reasons why FDI in services may have beneficial effects on domestic manufacturing firms' productivity. It has been argued that the liberalization and deregulation of services has brought substantial benefits to the manufacturing sector in the form of cost reduction, increased variety, availability and better quality of inputs (Horn and Wolinsky, 1988: Oulton, 2001; Barone and Cingano, 2011; Bourlès et al. 2013). Markusen et al. (2005) develop a theoretical model to quantitatively assess the impact of the liberalization of FDI in services and argue that services produced by foreign firms may act as a complement to domestic services, thus helping domestic firms to become competitive in international markets. Greater variety of services limits disruptions in production, reduces costs and makes the production process more reliable (Arnold et al., 2011; Fernandes and Paunov, 2012). Apart from increased competition which results in reductions in input prices (Barone and Cingano, 2011; Bourlès et al., 2013), the superior technology of MNCs evident in their managerial, marketing and organizational know-how, innovative and knowledge intensive inputs and internationally tested best practices (Mirodout, 2006; Miozzo and Grimshaw, 2008) may lead to improvements in quality of services provided and increase the TFP and innovative capability of domestic firms (Kox and Rubalcaba, 2007; Mas-Verdu et al. 2011; Evangelista et al., 2013). Moreover, inputs from the service sector, such as internet banking, may embody the technological knowledge which allows manufacturing firms to improve their production and operations. In comparison with material inputs, services inputs benefit a wider range of clients (Farole and Winkler, 2014). The limited micro level evidence suggests a positive association between the liberalization of FDI in services on downstream manufacturing productivity in the Czech Republic (Arnold et al., 2011), Chile (Fernandes and Paunov, 2012), India (Arnold et al., 2016), and Italy (Mariotti et al., 2013).

The capacity to affect the productivity and efficiency of client firms is highly differentiated within the heterogeneous universe of services depending on the degree of tacit and codified knowledge (Consoli and Elche-Hortelano, 2010), innovation potential and qualitative and innovative content of specific services provided to the clients (Evangelista et al., 2013). Although improvements in ICT suggest that the proximity and geographical concentration no

longer matter, knowledge intensive business services (KIBS) heavily rely on tacit or combination of codified and tacit knowledge (Miles, 2005; Kox and Rubalcaba, 2007; Shearmur and Doloreux, 2008), thus making spatial proximity a fundamental attribute (Koch and Stahlecker, 2006; Landry et al., 2012; Doloreaux and Sharmour, 2012; Ciarli et al. 2012). A defining feature of KIBS is that knowledge is their essential asset (Miles, 1994). They provide intermediate products to companies and offer intangible services with the possibility of high adaptation according to the client needs (den Hertog, 2000; Toivonen, 2004). Their continuous creation and transfer of knowledge requires cooperation and high interaction with customers in order to transfer tacit knowledge (Koch and Stahlecker, 2006; Arundel et al., 2007; Doloreaux and Shearmur, 2012). This in turn creates the incentive for MNCs to internationalize their knowledge intensive activities through investing abroad (Miozzo and Soete, 2001), and providing stronger forward linkages with their clients (Miozzo and Grimshaw, 2008; Mariotti et al., 2013). Hence, MNCs in KIBS are inherently different from those in manufacturing industries. KIBS can supply various types of inputs at varying levels of complexity, which support and/or improve the users' existing innovation processes (Shearmur and Doloreux, 2013). In this context, they bring new knowledge, provide solutions and add or compensate for missing internal capacity by transforming information and knowledge into personalized solutions aimed at specific users' needs (Tether and Hipp, 2002). Internationalized firms in the manufacturing sector are often required to develop new routines and organizational processes and therefore must acquire new knowledge (Ripolles-Melia et al., 2010). This implies that the interaction with KIBS may increase their internal capabilities (Shearmur et al., 2015).

Based on the discussion above, the following hypotheses will be tested in this paper:

H4: The presence of MNCs in services is positively related to the productivity of downstream manufacturing firms

H5: The effects of forward linkages from services on downstream manufacturing firms is reinforced by the presence of MNCs in knowledge intensive services

3. EMPIRICAL STRATEGY

3.1 ESTIMATING FIRMS' PRODUCTIVITY

The literature on the estimation of TFP at firm level has developed significantly over the past years. The original approach of estimating a Cobb-Douglas production function using OLS method was criticised for producing biased results due to the endogeneity of factor inputs and the unobserved productivity (Marschak and Andrews, 1944). In response to this, Olley and Pakes (1996), Levinsohn-Petrin (2003) and Ackerberg et al. (2006) developed a semi-parametric estimator that imposes a certain structure on firm behaviour and timing of factor inputs. The TFP estimates in this study are obtained using Wooldridge (2009) estimator as implemented by Petrin et al. (2011) and Petrin and Levinsohn (2012). This approach is in several ways superior to Olley and Pakes (OP) and Levinsohn and Petrin (LP) estimators.[3]

Production functions have been estimated for each country-industry combination identified by 2-digit NACE Rev. 1.1 classification to account for the heterogeneity arising from different production technologies, quality and intensity of inputs.[4] Output is measured by the value added, labour by the number of employees, capital by the book value of tangible fixed assets, and intermediate inputs are proxied by the cost of materials. Monetary values were deflated using industry price indices obtained from the OECD STAN database.

3.2 MEASUREMENT OF FDI SPILLOVER VARIABLES

In order to estimate the spillovers from the operation of foreign firms in manufacturing or services on the productivity of manufacturing firms, we define three types and measures of spillovers: horizontal, vertical backward and vertical forward. The last two are further divided into spillovers from MNCs in the manufacturing and service sectors. Horizontal spillovers for each industry-year are defined as:[5]

[3] First, it allows for simultaneous determination of factor inputs and technical efficiency. Second, it provides efficient standard errors robust to both heteroscedasticity and autocorrelation which is not the case with other structural estimators that rely on bootstrapped standard errors. Third, it is robust to Ackerberg et al. (2006) critique where labour may be unidentified in the first stage of the LP estimator.

[4] In order to satisfy the requirement of at least 50 observations per industry (Gal, 2013), some industries in each country have been merged based on the grouping used in the WIOD database.

[5] When calculating horizontal spillover measure, we included all firms in the database regardless of whether or not they were included in the TFP estimation (some firms were excluded from the latter because the data for some of the production function variables were missing).

$$Horz_{jt} = \frac{\sum_{i \epsilon j}(Foreign_{it} * Y_{it})}{\sum_{i \epsilon j} Y_{it}} \quad (1)$$

where Y_{it} is the output (measured as revenue) produced by firm *i* in industry *j* in year *t* and *Foreign* is a dummy variable taking value of one if the sum of shares of foreign investors in firm *i* exceeds 10% of the firm's equity and zero otherwise. The horizontal measure captures the share of foreign firms in the total output produced in industry *j* in time *t.* It is a measure of both demonstration and imitation effects.

Vertical spillovers measures are calculated to examine the link between the manufacturing firms' productivity and the foreign suppliers (forward) and customers (backward) in both manufacturing and services. Since information on individual firms' inputs is not available, we follow the standard practice in the literature (Javorcik, 2004; Arnold et al., 2011) and use the information on the links between 2-digit industries obtained from the World Input-Output Database (WIOD). The firm's input from other firms (or its sales to other firms) are approximated by the relationships between the industries of these firms as indicated by each country's input-output tables. Information on inter-industry sourcing from the WIOD are then combined with information on sales of foreign firms in each sector obtained from the Amadeus database. WIOD provides annual input-output tables, with a significant improvement over previous studies in measuring inter-industry sourcing behaviour. The use of annual input-output tables allows us to integrate into the analysis the most recent developments in firm behaviour, i.e. the increased splintering of the value chain as well as intensified outsourcing and offshoring behaviour (Baldwin and Lopez-Gonzalez, 2013).

The vertical backward and forward spillovers from the presence of foreign firms in manufacturing and services are defined as:

$$Backward_{jt}^{z} = \sum_{k=1}^{K} \alpha_{jkt} Horz_{kt}^{z} \quad , \quad z = \text{services or manufacturing} \quad (2)$$

$$Forward_{jt}^{z} = \sum_{l=1}^{L} \gamma_{jlt} Horz_{lt}^{z} \quad , \quad z = \text{services or manufacturing} \quad (3)$$

where α_{jkt} is the share of manufacturing industry *j*'s output sold to the downstream industry *k* while γ_{jlt} is the share of total inputs sourced from sector *l* to manufacturing sector *j*. $Horz$ is the horizontal spillover measure given above. The technical coefficients α_{jkt} and γ_{jlt} in the

backward and forward spillover measures are obtained from the annual I-O tables while the horizontal spillovers are calculated using firm level information from the Amadeus database.[6]

3.3 EMPIRICAL MODEL

The relationship between FDI and productivity is analysed by using a system-GMM approach (Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998).[7] There are two main reason for the choice of this method. First, since FDI is more likely to go to industries or regions that exhibit higher productivity ex ante, a positive correlation between FDI and productivity of domestic firms might simply reflect the location decision by foreign investors rather than positive spillover effects (Hale and Long, 2011). In addition, large and more productive manufacturing firms may lobby for the liberalization of particular service subsectors, thus generating a reverse causality situation and an upward bias in the coefficients of vertical linkages from services (Shepotylo and Vakhitov, 2015). Also, strong productivity growth of manufacturing firms may have attracted MNCs due to strong demand. The second reason is the dynamic nature of TFP, a static specification of which would be inappropriate given the autoregressive structure assumed in semi-parametric estimators.

The baseline model has the following form:

$$\ln TFP_{ijt} = \beta_0 + \beta_1 \, ln\left(TFP_{ij,t-1}\right) + \beta_2 MNC_{jt} + \beta_3 DF_{it} + \beta_4 IND_{jt} + \theta_j + \theta_r + \theta_t + \varepsilon_{ijt} \qquad (4)$$

where $ln\ TFP_{ijt}$ is the logarithm of total factor productivity of firm i in industry j at time t, $MNC_{j,t}$ is a vector of spillover measures as defined above, DF_{it} is a vector of firm level determinants of TFP, and IND_{jt} is a vector of variables controlling for competition and demand effects in industry j. Finally, $\theta_j, \theta_r, \theta_t$ denote industry (NACE 1.1), region (NUTS3) and time dummies to control for the unobserved effects such as the economy-wide technological

[6] Javorcik (2004) suggests to exclude the inputs supplied within the same industry while computing the technical coefficients α_{jkt} and γ_{jlt}. We depart from this approach due to relatively high aggregation of industries in WIOD; the exclusion of inputs supplied within the same 2-digit industry would cause productivity spillovers occurring at lower levels of aggregation to be captured by horizontal spillovers and lead to underestimation of vertical spillovers (Barbosa and Eiriz, 2009).

[7] The lagged dependent variable was treated as predetermined while variables measuring FDI spillovers (horizontal, backward and forward) are treated as endogenous and as such are instrumented with their own lags and lagged differences. The initial specifications included the minimum number of lags, i.e. one lag for levels and differences in case of lagged dependent variable and two lags for FDI spillover variables (Roodman, 2009). However, in certain cases model diagnostics with minimum number of lags were not satisfied and therefore the instrument matrix included higher order lags (three or four) of the regressors.

progress, macro productivity shocks, changes in specialization of certain industries and agglomeration economies that may also affect firm productivity.

The firm level controls include two variables to capture firm's absorptive capacity. The first one is the firm's employees' skill level proxied by the average labour cost, i.e. the ratio of total labour cost to the number of employees in the firm (Wagner, 2012). The second variable is the firm's endowment of specific advantages proxied by the ratio of intangible assets to tangible fixed assets. Both variables are measured in logarithms. Additionally, we control for firm's age in years and size measured by firm's total assets in logarithms. These two variables are included in quadratic form to control for possible nonlinear effects.

As for industry controls, *Herfindahl-Hirshman concentration index* is used to account for the intensity of competition. It is defined as the sum of the squares of the sales shares of all firms in industry *j* at time *t*. The inclusion of the concentration measure is particularly important for the measurement of horizontal and forward spillovers as it is expected that increased entry of MNCs would lead to efficiency increases due to increased competition. To isolate the effects of increased competition and knowledge spillovers it is important to separate these two effects (Javorcik, 2004). Demand variable on the other hand controls for increased demand in downstream sectors due to entry of MNCs:

$$Demand_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Y_{kt} \qquad (5)$$

where α_{jkt} represents the share of industry *j's* output needed to produce one unit of industry *k*'s output at time *t* and Y_{kt} is the total real output of industry *k* derived from the input-output tables (WIOD). Increased demand may induce scale economies which may be translated into higher TFP of local supplying firms.

3.4 DATA AND DESCRIPTIVE STATISTICS

Central to the empirical analysis is the firm level Amadeus database provided by Bureau van Dijk (BvD) which contains the balance sheet and income statement information for a very large number of firms in each country under consideration.[8] Amadeus also provides other firm level information relevant for our analysis such as detailed ownership information. In order to

[8] The data is taken from the "full" version of Amadeus database with no size threshold following Eapen (2013) who suggests that in incomplete datasets such as Amadeus the effects of FDI productivity spillovers may be overestimated due to selection effects if one excludes small firms from the sample.

identify foreign firms, we rely on direct ownership since this is taken from national sources and is not amended by BvD.[9] After cleaning the dataset for the purpose of productivity estimation, the final sample contains an unbalanced panel of 20,050 domestic firms during the 2002-2010 period - 95,875 firm-year observations in 23 manufacturing industries (at 2 digit NACE, Rev. 1.1 classification).[10] Table A1 in the Appendix presents the number of domestic firms' observations in each country used in the estimation of TFP classified according to Eurostat classification of technology intensive industries. In order to construct the measures of intra and inter-industry spillovers we rely on the information presented in Table A2 which shows the total number of foreign and domestic firms before data cleaning. Between 66 and 80 percent of total number of foreign firms are in services. A closer look reveals that a majority of foreign firms operate in less knowledge and market knowledge intensive services while a relatively smaller proportion operate in manufacturing, mainly in medium high and medium low technology industries.

Table 1 presents summary statistics of variables used in the estimation of spillovers (Section 4). As can be seen, the share of foreign firms' output in manufacturing ranges from 3 to 35 percent in Slovenia and Estonia, respectively. These shares hide significant differences across different industries (Figure A1 in the Appendix) - 55 percent of total output in transport equipment is produced by foreign firms in comparison to only 13 percent in textile industry. The foreign presence is also significant in electrical and optical equipment industry, chemical industry, production of coke and fuels, non-metallic mineral products and rubber and plastics. A more detailed analysis of vertical linkages across industries and countries is provided in Figures A2 and A3 in the Appendix. In general, backward linkages from manufacturing and forward linkages from services provide the largest potential for knowledge transfer.

[9] A firm is defined as foreign if identified foreign shareholders have acquired at least 10 per cent of its equity (IMF, 2009).

[10] For the construction of TFP sample we need information on firms' sales, tangible fixed assets, number of employees and expenditure on materials. Firms with missing, negative or zero values for any of the variables of interest are dropped from the sample. We have also eliminated observations for which accounting rules are violated. In order to avoid the extreme effects of outliers and aberrant values due to typing errors during data entry we have computed output to labour ratio, value added to labour ratio, capital to output ratio, labour to output ratio and dropped firms below the 1st percentile and above 99th percentile of their respective distributions.

Table 1. Summary statistics

	Czech Republic		Estonia		Hungary		Slovakia		Slovenia	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
ln TFP	3.51	0.99	2.70	0.81	4.17	1.02	3.34	0.97	3.87	0.86
Horizontal	0.30	0.17	0.36	0.17	0.23	0.15	0.25	0.22	0.03	0.10
Manufacturing backward	0.13	0.08	0.10	0.06	0.12	0.07	0.13	0.09	0.05	0.04
Manufacturing forward	0.07	0.05	0.05	0.03	0.07	0.04	0.05	0.04	0.01	0.01
Services backward	0.04	0.02	0.07	0.03	0.03	0.01	0.04	0.02	0.02	0.01
Services forward	0.08	0.03	0.13	0.06	0.08	0.02	0.08	0.04	0.05	0.03
Services LKIS	0.03	0.01	0.09	0.04	0.04	0.01	0.03	0.02	0.04	0.03
Services KIS	0.03	0.01	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.01
ln Intangibles	-4.70	1.99	-4.20	1.99	-4.77	2.04	-5.19	1.89	-4.54	1.95
ln Human capital	2.19	0.59	1.75	0.69	2.47	0.49	2.16	0.75	2.75	0.38
Age	9.86	5.06	8.75	7.30	12.17	5.21	9.73	6.61	11.49	6.54
Age squared	122.89	143.22	129.71	445.96	175.30	221.41	138.29	319.58	174.75	225.19
ln Size	6.76	1.85	5.07	1.81	8.86	1.41	7.17	1.80	6.33	1.52
ln Size squared	49.15	26.54	29.03	20.07	80.44	26.33	54.70	26.49	42.40	20.50
HHI	0.03	0.06	0.08	0.08	0.11	0.14	0.08	0.10	0.16	0.15
ln Demand	8.14	1.01	5.75	0.97	8.60	0.82	8.56	1.29	6.98	0.89

4. EMPIRICAL FINDINGS AND DISCUSSION OF RESULTS

This section presents the results of the model estimations. As system-GMM relies on internal instruments to deal with possible endogeneity, the Hansen J test of the validity of instruments together with autocorrelation test results are reported in the model diagnostics. In all models presented in the study, the Hansen J test cannot be rejected suggesting that employed instruments are satisfactory. Arellano and Bond test for autocorrelation confirms the absence of autocorrelation in second differences while rejecting the null hypothesis of no first order autocorrelation. Furthermore, the assumptions of no cross sectional dependence and steady state are verified by the difference in Hansen C tests, respectively, for the lagged dependent variable and the equation in levels, suggesting that the models are correctly specified. We have also checked for potential multicollinearity which produces imprecise estimates and makes inference unreliable. Due to space restriction, matrices of estimated correlation coefficients are reported in Table A3. We have also calculated Variance Inflation Factors (VIF) for each variable used in the estimation. Since VIF for all variables take the value less than ten we are confident that our results are not plagued by multicollinearity issues.

4.1 BASELINE MODEL

Table 2 presents the results for the baseline model. The estimates for the horizontal spillover measure point to negative effects of foreign firms' presence in the same industry (rejecting H1a and supporting H1b) confirming some of the previous findings that foreign firms have strong incentives to prevent the leakage of embodied knowledge and technologies to their direct domestic competitors (Javorcik, 2004; Iršová and Havránek, 2013; Newman et al., 2015).

Table 2. System-GMM results of FDI productivity spillovers, baseline model

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
Lagged ln TFP	0.385***	0.267***	0.600***	0.385***	0.431***
	(0.022)	(0.027)	(0.114)	(0.043)	(0.057)
Horizontal	-0.167**	-0.635***	-0.701**	-0.383*	0.206
	(0.083)	(0.158)	(0.343)	(0.198)	(0.356)
Backward_manufacturing	1.740***	-0.597*	2.765**	1.815*	1.841**
	(0.599)	(0.339)	(1.355)	(1.100)	(0.933)
Forward_manufacturing	-2.573***	-1.331***	-3.082**	-0.257	-0.333
	(0.485)	(0.409)	(1.373)	(0.495)	(1.430)
Backward_services	-7.576***	1.286*	-20.662***	5.331*	-9.719**
	(2.158)	(0.674)	(6.324)	(2.801)	(4.698)
Forward_services	4.417***	3.110***	6.913*	6.150***	13.599***
	(1.492)	(0.710)	(4.147)	(1.752)	(5.205)
ln Human capital	0.482***	0.488***	0.295***	0.332***	0.526***
	(0.014)	(0.016)	(0.061)	(0.014)	(0.045)
ln Intangibles	0.045***	0.077***	0.008*	0.060***	0.029***
	(0.003)	(0.006)	(0.004)	(0.005)	(0.006)
Age	-0.009***	-0.015***	-0.005	-0.009***	-0.010***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
Age squared	0.000*	0.000***	-0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln Size	0.213***	0.270***	0.080*	0.146***	-0.026
	(0.018)	(0.024)	(0.049)	(0.032)	(0.059)
ln Size squared	-0.004***	-0.007***	0.000	-0.003	0.011**
	(0.001)	(0.002)	(0.003)	(0.002)	(0.005)
HHI	-0.232***	0.241*	-0.142	-0.159	-0.189
	(0.062)	(0.136)	(0.116)	(0.106)	(0.132)
ln Demand	-0.033	-0.046	0.066	-0.020	0.029
	(0.024)	(0.033)	(0.047)	(0.016)	(0.100)
Model diagnostics					
No. of observations	29,263	11,451	2,499	8,140	3,584
No. of groups	9,712	2,870	1,278	3,074	1,136
No. of Instruments	55	86	107	60	81
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	0	0	0
AR(2) p-value	0.562	0.788	0.569	0.722	0.343
Hansen J Test p-value	0.106	0.107	0.682	0.755	0.353

Hansen C Test p-value (lagged dependent)	0.162	0.125	0.894	0.865	0.750
Hansen C Test p-value (equation in levels)	0.073	0.213	0.460	0.902	0.469

Notes: Robust standard errors in parenthesis.
**** significant at 10%, ** significant at 5%, and * significant at 1%.*

As far as backward linkages are concerned (H2), the results suggest that, in all countries except Estonia, the presence of foreign firms in downstream manufacturing sectors benefits domestic suppliers. The positive effects on local firms' productivity range from 1.7 per cent in the Czech Republic to 2.8 per cent in Hungary. These results are in line with most empirical studies (Havránek and Iršová, 2011) suggesting that countries such as the Czech Republic, Hungary and Slovakia which attracted large amount of FDI in tradable sectors are able to benefit from entering MNCs' production network.

Turning to backward linkages from services, positive effects on local firms' productivity are evident only in Estonia and Slovakia, and are larger in magnitude in comparison to backward linkages from manufacturing. On the other hand, negative backward linkages from services are evident in manufacturing firms in the Czech Republic, Hungary and Slovenia and offset any positive effects arising from FDI in manufacturing sector. These findings are in line with those obtained by Mariotti et al. (2013) who found that four service sectors exhibit negative effects on upstream manufacturing firms unless the entry of MNCs is able to increase demand for intermediate manufacturing inputs. Ayyagari and Kosova (2010) found similar results when investigating the effects of backward linkages from services on the entry of domestic firms. They explain this by the fact that manufacturing firms usually supply only limited amount of intermediate inputs to services in form of communication and information technology and office automation equipment. Since in these industries barriers to entry may be high and foreign presence is significant, services firms may be more inclined to source from their foreign suppliers.

The findings with respect to forward spillovers (H3) suggest that inputs supplied by MNCs in manufacturing sector have detrimental effects on TFP in all countries, but are only significant in the Czech Republic, Estonia and Hungary. A one percentage point increase in foreign presence in upstream manufacturing sector leads to decline in TFP levels between 1.3 and 3.1 percent in Estonia and Slovakia, respectively. The results suggest that domestic firms may not have the capabilities to benefit from high quality inputs because of the difficulties in the integration of these into the production process. As evident from Figure 1A in Appendix A, an

alternative explanation is that foreign firms may have gained a dominant market position in upstream sectors such as electrical and optical equipment industry, transportation and other machineries, enabling them to gain market power and better bargaining position in the sector resulting in higher priced inputs (Newman et al., 2015).

In the case of forward spillovers from the service sector (H4), the results indicate the strong positive and significant effect of inputs from foreign owned services on downstream manufacturing productivity thus confirming previous findings on the beneficial effects of FDI in services (Arnold et al., 2011; Fernandes and Paunov, 2012; Mariotti et al., 2013). The short run effects range from 3.1 per cent in Estonia to 13.6 per cent in Slovenia. Such large semi-elasticities may reflect the FDI penetration ratios in the service sector due to recent liberalisation where effects are expected to be larger for an increase in foreign presence from small levels than in sectors where levels of FDI are already saturated (Gersl et al., 2008). The evidence seems to indicate that productivity spillovers are more easily captured by manufacturing customers that buy inputs from services MNCs than through backward services linkages or forward manufacturing linkages.

For variables measuring absorptive capacity, the empirical findings suggest a positive and significant relationship between the human capital measure and TFP across all countries. One percent increase in average wage leads to 0.29 per cent increase in productivity in Hungary and up to 0.53 per cent in Slovenia. Similarly, the intensive use of intangible assets has a positive and significant effect in all countries; this is in line with other empirical studies examining the impact of intangibles on productivity (Marrocu et al., 2012; Hall et al., 2013; Battistini et al., 2015). Firm age suggests a nonlinear relationship in almost all countries except in Hungary where it is not significant and in Slovenia where there seems to be a negative linear effect of age. Firm's size has a positive and significant effect in all countries, except Slovenia. Inverse-U shape effects can be found in the Czech Republic and Estonia suggesting that after firms achieve a certain size their effects on productivity starts to diminish. The effects of competition seem to be significant only in the Czech Republic and Estonia, but with opposite effects. In the former country, increase in competition benefits domestic firms' productivity, while opposite holds for Estonia. Finally, the effects of demand in downstream sectors are statistically insignificant.

4.2 MODERATING EFFECTS OF ABSORPTIVE CAPACITY

The occurrence of FDI spillovers is not an automatic process and does not benefit all firms equally. Supported by the results in the previous section and as noted by Cohen and Levinthal (1990) and George and Zahra (2002), absorptive capacity helps firms to identify, assimilate, transform and apply knowledge from the external environment. Therefore, benefits from FDI spillovers are more likely to occur in firms that are better able to absorb the technology that comes with MNCs. In this section we test whether the intensity of a firm's intangible assets has a moderating effect on FDI spillovers. The use of intangible assets has potentially several advantages over other measures of absorptive capacity.[11] First, intangible capital is a broader measure of absorptive capacity as it includes both innovation inputs and outputs developed in house or in arms-length transactions which leads to improvements in production process. Second, as suggested by Teece (2011) intangible assets consist of mostly non-codified knowledge and thus contribute to firm specific assets which in turn sustain firm competitiveness.[12] Third, intangible capital has been found to be a strong determinant of firm productivity in many studies (Syverson, 2011).

Based on the above discussion, we test an additional hypothesis:

H6: The magnitude of horizontal spillovers and vertical linkages is greater for domestic firms with higher intangible assets ratio.

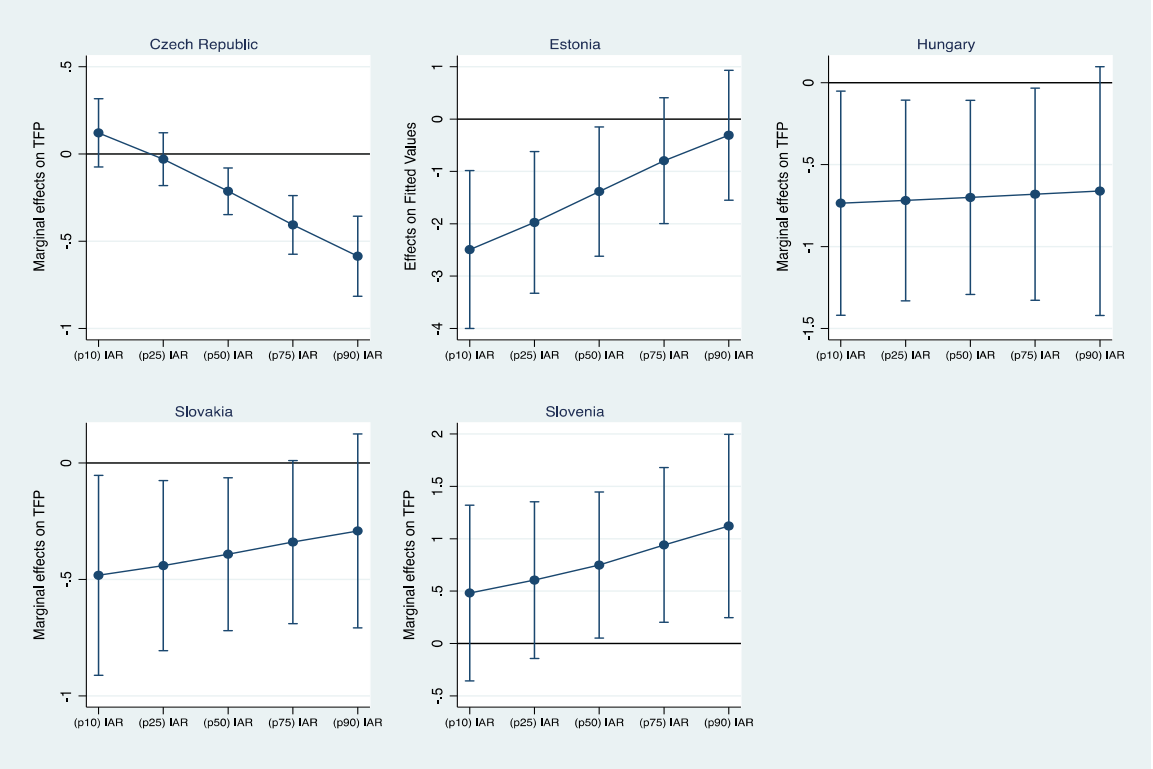
The model presented by equation (4) is now augmented by adding the interaction terms between each FDI spillover measure and the logarithm of intangible to tangible fixed assets ratio. Since the interaction terms include two continuous variables we present the marginal effects of FDI spillovers on TFP conditional on the values of intangible asset ratio at the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles. We find that the higher intensity of intangibles attenuates the negative horizontal spillover effects in Estonia and Slovakia while in Slovenia a statistically insignificant spillover effect at lower levels of intangible asset ratio becomes positive and significant at higher values (Figure 1). Results for the Czech Republic are contrary to

[11] An alternative measure of average wage in the establishment, as a proxy for the quality of human capital produced similar results to those reported here.

[12] For example, knowledge capital of the firm incorporated in intangible assets include R&D expenditure, software, patents, licences, designs, trademarks, organizational processes and firm specific skills that provide competitive advantages (Ragoussis, 2014).

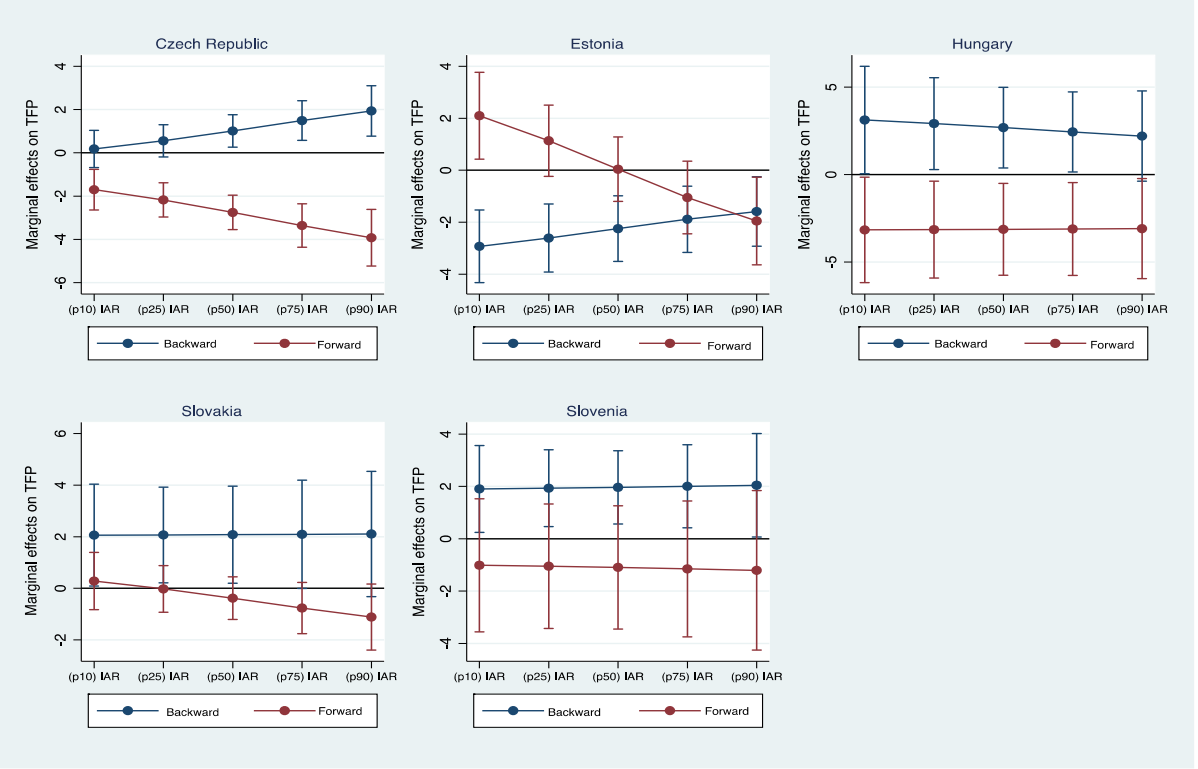
expectations as the negative horizontal spillover effects get stronger with increases in intangible assets.

Figure 1. Average marginal effects of horizontal spillovers across intangible assets ratio percentiles



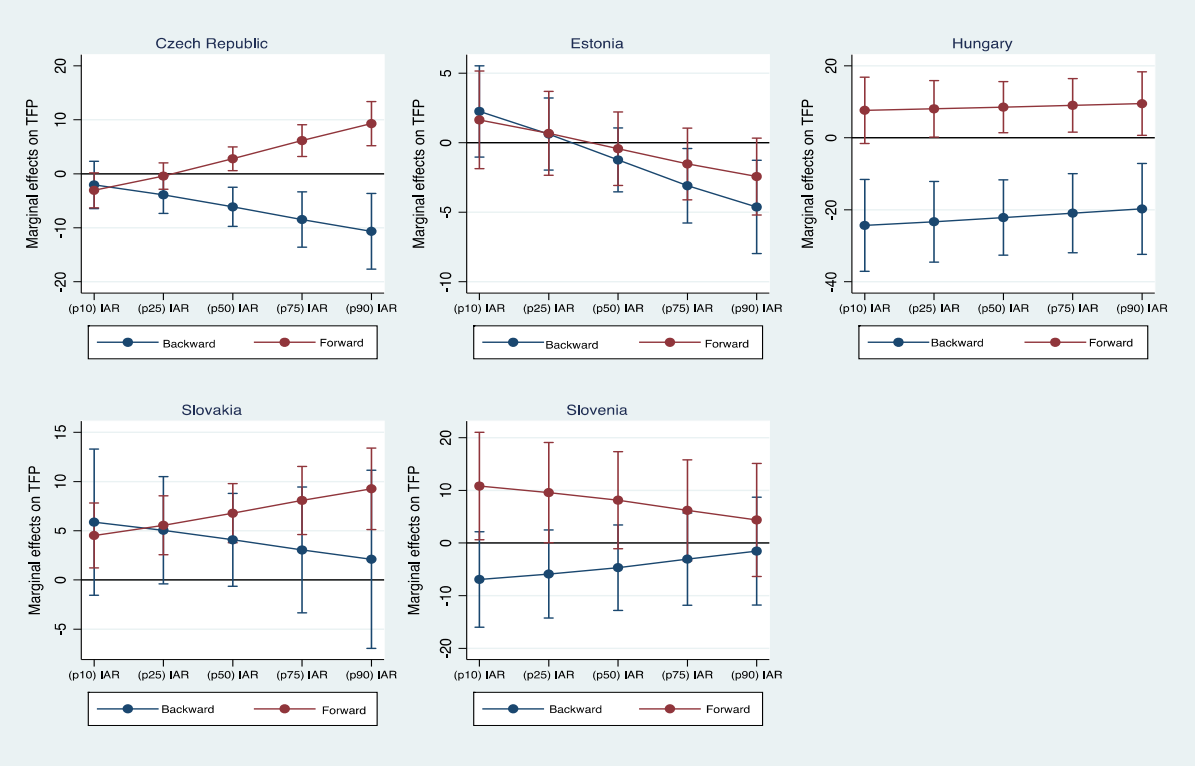
Turning to vertical linkages arising from manufacturing sectors, presented in Figure 2, findings suggest that domestic suppliers with higher absorptive capacity benefit from backward linkages only in the Czech Republic. In line with other studies, this result confirms the role of firm's absorptive capacity as an enabling factor for FDI spillovers (Crespo and Fontoura, 2007; Blalock and Gertler, 2008; Damijan et al., 2013). However, in other countries increases in absorptive capacity do not appear to lead to changes in the marginal effects on TFP. In case of forward linkages, the point estimates for the Czech Republic, Estonia, Slovakia suggest a declining impact with higher levels of intangible asset ratio, though the difference across different percentiles is not statistically significant, except in Estonia.

Figure 2. Average marginal effects of manufacturing vertical linkages across intangible assets ratio percentiles



Turning to linkages arising from the service sector, presented in Figure 3, the statistically insignificant effects of forward linkages becomes positive and significant for higher levels of intangible asset ratio in the Czech Republic while the moderating effects are insignificant in the rest of the countries. Finally, none of the countries examined appear to benefit from backward vertical linkages with increased levels of absorptive capacity.

Figure 3. Average marginal effects of services vertical linkages across intangible assets ratio percentiles



There may be a few potential reasons for these largely unexpected results for most countries. The proxy used for measuring absorptive capacity may not distinguish between different types of intangible capital; only externally acquired assets can be capitalized and therefore recognized as intangible asset while those assets generated internally is often expensed (Ragoussis, 2014). Even if intangible asset is bought on the market it requires specific dynamic capabilities to be accumulated and managed. Given rapid technological changes, the existence of organizational capabilities evident in routines and processes is required to refine and transform the knowledge (Nelson and Winter, 1982; Grant, 1996; Dosi et al., 2000; George and Zahra, 2002). Another critical resource in the process of intangible asset accumulation and exploitation is related to human capital (Abramovitz and David, 2000). Since the creation of specific competence in human capital requires hiring staff with higher education as well as formal and informal on-the-job training the costs may become too high causing firms to minimize investment in intangible asset (Cuervo-Cazurra and Un, 2009) and lead to

heterogeneous patterns of investment in, and management of, intangible assets (Arrighetti et al., 2015).[13]

4.3 THE IMPORTANCE OF KNOWLEDGE INTENSIVE SERVICES

This section aims to shed more light on the role of knowledge intensity by separating forward linkages from services to those coming from less and more knowledge intensive industries. We employ standard Eurostat definition of knowledge intensive (KIS) and less knowledge intensive services (LKIS) as in Masso and Vahter (2012).[14] The results of the augmented model where services forward linkages are now separated according to KIS and LKIS are presented in Table 3.

The results show that KIS drive the positive effects of services forward linkages reported in the baseline model in Table 3, thus supporting H5. The largest effects are experienced by domestic firms in Hungary, Slovenia and the Czech Republic where a one percentage point increase in foreign firms' presence in KIS results in an increase in TFP between 8.93 and 19.75 percent. The only country in which LKIS have any positive and significant effect is Slovenia. Since FDI is industry specific (Buckley et al., 2007; Wang et al., 2009) and technology characteristics as well as potential for knowledge absorption differ across industries (Spencer, 2008; Wang et al., 2012), we have further split manufacturing sector into high-tech and low-tech industries according to R&D intensity as defined by the OECD (2007). The results suggest significant positive effects of forward KIS on manufacturing firms in high-tech industries across all countries, except in Slovenia.[15] In addition, the beneficial effects of forward KIS on low-tech manufacturing firms are found in Hungary, Slovenia and Slovakia. In contrast, forward linkages from LKIS have mostly negative and significant effects on their downstream

[13] Economic competencies (e.g. human capital and organizational structure) are regarded as the most important part of intangible asset which are most difficult to measure and therefore are not included in the balance sheet. Given that they are important for the assimilation and exploitation of external knowledge, a limited set of capabilities included in our measure may hamper the complementarities between different types intangible asset and result in insignificant or in some cases negative moderating effects.

[14] Within the NACE 1.1 classification system the following industries are defined as knowledge intensive service sectors: water transport (NACE code 61), air transport (62), post and telecommunications (64), financial intermediation (65), insurance (66), activities auxiliary to financial intermediation (67), real estate activities (70), renting of machinery and equipment (71), computer and related activities (72), research and development (73) and other business activities (74). On the other hand, less knowledge intensive services sectors are: wholesale and retail trade (50-52), hotels and restaurants (55), land transport (60), and supporting and auxiliary transport activities (63).

[15] Estimation results are not reported here for brevity of space. Full estimation results could be obtained from the authors on request.

manufacturing clients in both types of industries in all countries except Slovenia. Overall, these results complement previous studies which found KIS to have a positive impact on downstream clients (Camacho and Rodriguez, 2007; Mariotti et al., 2013; Evangelista et al., 2013).

Table 3. System-GMM results of FDI productivity spillovers, forward KIS vs. LKIS linkages

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
Lagged ln TFP	0.473***	0.285***	0.621***	0.374***	0.436***
	(0.042)	(0.027)	(0.087)	(0.042)	(0.054)
Horizontal	-0.233***	-0.417**	-0.603*	-0.533**	0.136
	(0.072)	(0.178)	(0.321)	(0.231)	(0.315)
Backward_manufacturing	0.944***	-0.926**	1.178	2.469*	1.458*
	(0.294)	(0.405)	(1.377)	(1.357)	(0.775)
Forward_manufacturing	-0.719	-0.739	-2.808*	-4.376**	0.152
	(1.853)	(0.553)	(1.470)	(2.024)	(1.251)
Backward_services	-8.240***	1.230*	-16.014***	1.945	-8.713*
	(1.657)	(0.740)	(5.581)	(3.710)	(4.573)
ForwardKIS	8.932***	2.229*	19.748**	3.432*	13.212*
	(3.092)	(1.283)	(8.586)	(2.029)	(7.732)
ForwardLKIS	-1.102	0.200	2.615	0.465	12.652***
	(1.680)	(1.919)	(7.858)	(0.340)	(4.806)
ln Human capital	0.435***	0.481***	0.278***	0.335***	0.509***
	(0.024)	(0.016)	(0.049)	(0.015)	(0.043)
ln Intangibles	0.038***	0.073***	0.007*	0.060***	0.028***
	(0.004)	(0.006)	(0.004)	(0.005)	(0.005)
Age	-0.007***	-0.015***	-0.005	-0.009***	-0.011***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Age squared	0.000**	0.000***	-0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln Size	0.161***	0.251***	0.064	0.151***	-0.001
	(0.029)	(0.030)	(0.049)	(0.032)	(0.056)
ln Size squared	-0.003***	-0.006**	0.001	-0.003	0.008*
	(0.001)	(0.003)	(0.003)	(0.002)	(0.004)
HHI	-0.295***	0.306	-0.208**	-0.114	-0.215*
	(0.063)	(0.244)	(0.099)	(0.109)	(0.124)
ln Demand	-0.000	-0.022	0.103*	-0.009	-0.003
	(0.019)	(0.038)	(0.058)	(0.018)	(0.062)
Model diagnostics					
No. of observations	29,263	11,451	2,499	8,140	3,584
No. of groups	9,712	2,870	1,278	3,074	1,136
No. of instruments	60	68	95	66	90
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	0	0	0
AR(2) p-value	0.578	0.589	0.578	0.781	0.330
Hansen J Test p-value	0.262	0.261	0.796	0.677	0.449
Hansen C Test p-value (lagged dependent)	0.480	0.880	0.877	0.905	0.262
Hansen C tests p-value (levels equation)	0.218	0.318	0.900	0.880	0.266

Notes: Robust standard errors in parenthesis.
**** significant at 10%, ** significant at 5%, and * significant at 1%.*

5. CONCLUSION

This article explores the effects of FDI spillovers on productivity of domestic firms in the manufacturing sectors of five CEE countries (the Czech Republic, Estonia, Hungary, Slovakia and Slovenia) between 2002 and 2010. It contributes to the existing scarce literature on productivity spillovers arising from FDI in the service sector (Arnold et al., 2011; Fernandes and Paunov, 2012; Mariotti et al., 2013) by examining whether the increased presence of MNCs encouraged by the recent liberalization of services leads to productivity improvements of domestic manufacturing firms. To the best of our knowledge, this is the first empirical study using firm level data and annual input-output tables for CEE countries that also disentangles vertical linkages according to industry source.

The results suggest that local manufacturing firms benefit from the backward spillover effects of FDI in manufacturing and forward spillover effects of FDI in services. This confirms previous empirical findings that MNCs have a strong incentive to share knowledge with their suppliers. They are also consistent with the view that the liberalization of services and the subsequent increased entry of MNCs is associated with improved availability, range and quality of services resulting in improved performance of downstream manufacturing firms. Additionally, we found that the positive spillovers of FDI in services to manufacturing clients is driven by the presence of foreign firms in KIS. These positive effects are reversed in the case of manufacturing forward linkages. MNCs in manufacturing have negative effects on their local customers that outweigh positive effects on their suppliers. In addition, local manufacturing supplier firms do not benefit from increased presence of MNCs in services except in Slovakia and Hungary.

We further contribute to the literature by investigating the moderating effects of absorptive capacity. We find that gains from the presence MNCs do not accrue equally to all firms. Those firms in the Czech Republic that have higher intensity of intangible asset ratio as a proxy for absorptive capacity are more likely to benefit from manufacturing backward and services forward linkages while the negative effects of intra industry spillovers are attenuated in Estonia and Slovakia.

Given the positive impact of foreign entry in services, in particular the KIS, on the performance of downstream manufacturing firms, policy makers should make every effort to encourage the greater presence of MNCs in services. However, if the negative effects of backward linkages from services are quantitatively larger than forward linkages, the overall effects of FDI in services may hurt domestic suppliers' productivity. Therefore, in order to maximise the benefits of FDI in services, governments should provide information about any industry specific requirements needed by MNCs in order to facilitate the creation of vertical linkages and entry of indigenous firms into global value chains.

In addition, given that manufacturing customers in high-tech sectors benefit more from services inputs, especially those coming from knowledge intensive services, managers of local manufacturing firms should ensure the assimilation and exploitation of the existing knowledge to increase their technological capabilities that would result in new processes, products and services.

The paper could be extended in several dimensions. Recent IB studies have started looking at technological development, strategies and internal structure of MNCs and their effects on spillovers (Ghauri and Yamin, 2009). Given the importance of foreign firms' heterogeneity in terms of nationality, mode of entry, extent of ownership, intra firm strategies such as autonomy and technological capabilities and the nature and level of embeddedness of subsidiaries in local economy (Giroud, 2012), one should explore these issues in more depth. Furthermore, the heterogeneity of domestic firms in terms of international orientation, the level of internationalization and technological capabilities, and other factors influencing the scope and magnitude of spillovers should be taken into account. Unfortunately, the lack of detailed data regarding such characteristics hinders current empirical investigation. Finally, following Mariotti et al. (2015), further research could explore the role of spatial proximity of domestic and foreign firms. This would provide a promising step in advancing and understanding of the mechanism underlying productivity spillovers to domestic firms.

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APPENDIX

Table A1. Number of observations (domestic firms only) used in TFP estimation

	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
High tech manufacturing	3,439	424	338	493	192
Medium high tech manufacturing	16,027	1,596	966	2,983	869
Medium low tech manufacturing	20,029	3,784	1,448	4,036	2,247
Low tech manufacturing	19,762	9,228	1,539	4,478	1,997
Total	**59,257**	**15,032**	**4,291**	**11,990**	**5,305**

Table A2. Number of firms per industry and country over the 2002-2010 period in the original sample

	Czech Republic		Estonia		Hungary		Slovakia		Slovenia	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Construction	134,352	1,119	43,096	1,263	88,475	145	71,102	199	15,259	55
High tech manufacturing	2,032	170	241	60	2,642	27	1,231	42	280	4
Medium high tech manufacturing	9,400	733	837	145	5,929	86	3,643	212	1,086	25
Medium low tech manufacturing	14,997	838	1,914	222	9,981	118	7,605	226	2,278	22
Low tech manufacturing	21,025	635	4,420	390	20,939	99	12,865	184	3,323	28
High knowledge intensive services	7,749	482	5,456	527	26,040	68	5,372	102	3,758	66
Market knowledge intensive services	109,401	6,309	25,157	2,212	105,204	349	41,912	496	15,649	97
Less knowledge intensive services	155,220	5,540	25,872	2,323	118,056	490	90,932	1,357	20,602	386
Total	**454,176**	**15,826**	**106,993**	**7,142**	**377,266**	**1,382**	**234,662**	**2,818**	**62,235**	**683**

Table A3a. Correlation matrix – Czech Republic

	TFP	Horizontal	Manufacturing backward	Manufacturing forward	Services backward	Services forward	Demand	HHI	Age	Size	Average wage	Intangibles
TFP	1.00											
Horizontal	0.12	1.00										
Manufacturing backward	0.04	0.14	1.00									
Manufacturing forward	0.16	0.22	0.40	1.00								
Services backward	-0.02	0.19	-0.26	0.09	1.00							
Services forward	0.06	0.37	0.48	0.31	0.33	1.00						
Demand	0.06	0.28	0.43	-0.04	-0.37	-0.12	1.00					
HHI	0.02	0.17	-0.04	-0.05	-0.01	-0.01	0.04	1.00				
Age	0.07	0.12	0.05	0.11	0.08	0.19	-0.09	-0.02	1.00			
Size	0.57	0.13	-0.01	0.09	-0.01	0.02	0.02	0.08	0.23	1.00		
Average wage	0.59	0.17	0.11	0.18	0.04	0.13	0.11	-0.01	0.07	0.30	1.00	
Intangibles	-0.04	-0.04	0.00	0.04	0.01	-0.02	0.02	0.00	-0.19	-0.40	-0.03	1.00

Table A3b. Correlation matrix – Estonia

	TFP	Horizontal	Manufacturing backward	Manufacturing forward	Services backward	Services forward	Demand	HHI	Age	Size	Average wage	Intangibles
TFP	1.00											
Horizontal	0.02	1.00										
Manufacturing backward	0.02	0.41	1.00									
Manufacturing forward	0.01	0.12	0.53	1.00								
Services backward	0.12	0.42	0.41	0.26	1.00							
Services forward	0.10	0.61	0.73	0.42	0.78	1.00						
Demand	-0.09	-0.14	-0.45	-0.36	-0.14	-0.37	1.00					
HHI	0.02	0.44	0.14	-0.08	0.13	0.20	-0.14	1.00				
Age	0.14	0.13	0.07	-0.02	0.11	0.14	-0.09	0.07	1.00			
Size	0.61	0.15	0.05	-0.01	0.07	0.12	-0.03	0.15	0.32	1.00		
Average wage	0.64	0.26	0.22	0.11	0.34	0.39	0.00	0.10	0.19	0.54	1.00	
Intangibles	-0.30	-0.01	0.02	0.02	0.06	0.02	-0.05	-0.01	-0.23	-0.70	-0.29	1.00

Table A3c. Correlation matrix - Hungary

	TFP	Horizontal	Manufacturing backward	Manufacturing forward	Services backward	Services forward	Demand	HHI	Age	Size	Average wage	Intangibles
TFP	1.00											
Horizontal	-0.24	1.00										
Manufacturing backward	-0.42	0.23	1.00									
Manufacturing forward	-0.35	0.50	0.58	1.00								
Services backward	0.01	-0.06	-0.08	-0.21	1.00							
Services forward	-0.34	0.25	0.50	0.50	0.48	1.00						
Demand	-0.03	-0.08	0.20	0.01	-0.18	-0.02	1.00					
HHI	0.00	0.33	0.01	0.10	-0.11	0.06	-0.05	1.00				
Age	0.02	-0.03	0.00	0.02	0.05	0.05	0.01	-0.07	1.00			
Size	0.49	0.15	-0.13	0.01	0.00	-0.03	0.03	0.11	0.12	1.00		

Average wage	0.35	0.14	0.09	0.15	0.17	0.18	0.11	0.00	0.08	0.37	1.00	
Intangibles	0.10	0.06	0.03	0.06	0.05	0.07	0.07	0.05	-0.03	0.05	0.20	1.00

Table A3d. Correlation matrix - Slovakia

	TFP	Horizontal	Manufacturing backward	Manufacturing forward	Services backward	Services forward	Demand	HHI	Age	Size	Average wage	Intangibles
TFP	1.00											
Horizontal	0.11	1.00										
Manufacturing backward	-0.11	0.22	1.00									
Manufacturing forward	0.13	0.31	0.47	1.00								
Services backward	0.14	0.22	0.21	0.48	1.00							
Services forward	-0.05	0.29	0.47	0.42	0.58	1.00						
Demand	-0.08	0.01	0.15	0.03	-0.22	0.10	1.00					
HHI	0.09	0.17	-0.26	-0.09	0.05	-0.11	-0.32	1.00				
Age	-0.05	0.03	0.01	0.05	0.08	0.10	-0.04	0.01	1.00			
Size	0.37	0.08	-0.08	-0.02	-0.08	-0.03	-0.01	0.09	0.09	1.00		
Average wage	0.46	0.05	0.07	0.08	0.04	0.03	0.09	0.00	-0.08	0.23	1.00	
Intangibles	0.15	0.04	0.05	0.08	0.05	-0.01	0.00	0.00	-0.09	-0.28	-0.03	1.00

Table A3e. Correlation matrix - Slovenia

	TFP	Horizontal	Manufacturing backward	Manufacturing forward	Services backward	Services forward	Demand	HHI	Age	Size	Average wage	Intangibles
TFP	1.00											
Horizontal	0.04	1.00										
Manufacturing backward	-0.06	0.05	1.00									
Manufacturing forward	-0.01	0.19	0.68	1.00								
Services backward	0.05	0.43	0.21	0.38	1.00							
Services forward	0.02	0.46	0.58	0.72	0.79	1.00						

Demand	0.02	-0.36	0.19	0.14	-0.20	-0.17	1.00					
HHI	0.07	0.28	-0.24	-0.10	0.12	0.08	-0.52	1.00				
Age	0.04	0.03	0.01	0.04	0.07	0.06	-0.03	-0.01	1.00			
Size	0.55	0.10	-0.03	0.03	0.05	0.07	-0.07	0.12	0.23	1.00		
Average wage	0.56	0.14	0.14	0.17	0.21	0.25	-0.01	0.01	0.11	0.41	1.00	
Intangibles	0.07	0.05	-0.03	-0.03	0.03	0.01	-0.09	0.11	-0.13	-0.24	-0.03	1.00

Figure A1. The share of foreign firms in industry output by country and industry

Figure A2. Average size of manufacturing backward and forward linkages across countries and manufacturing industries

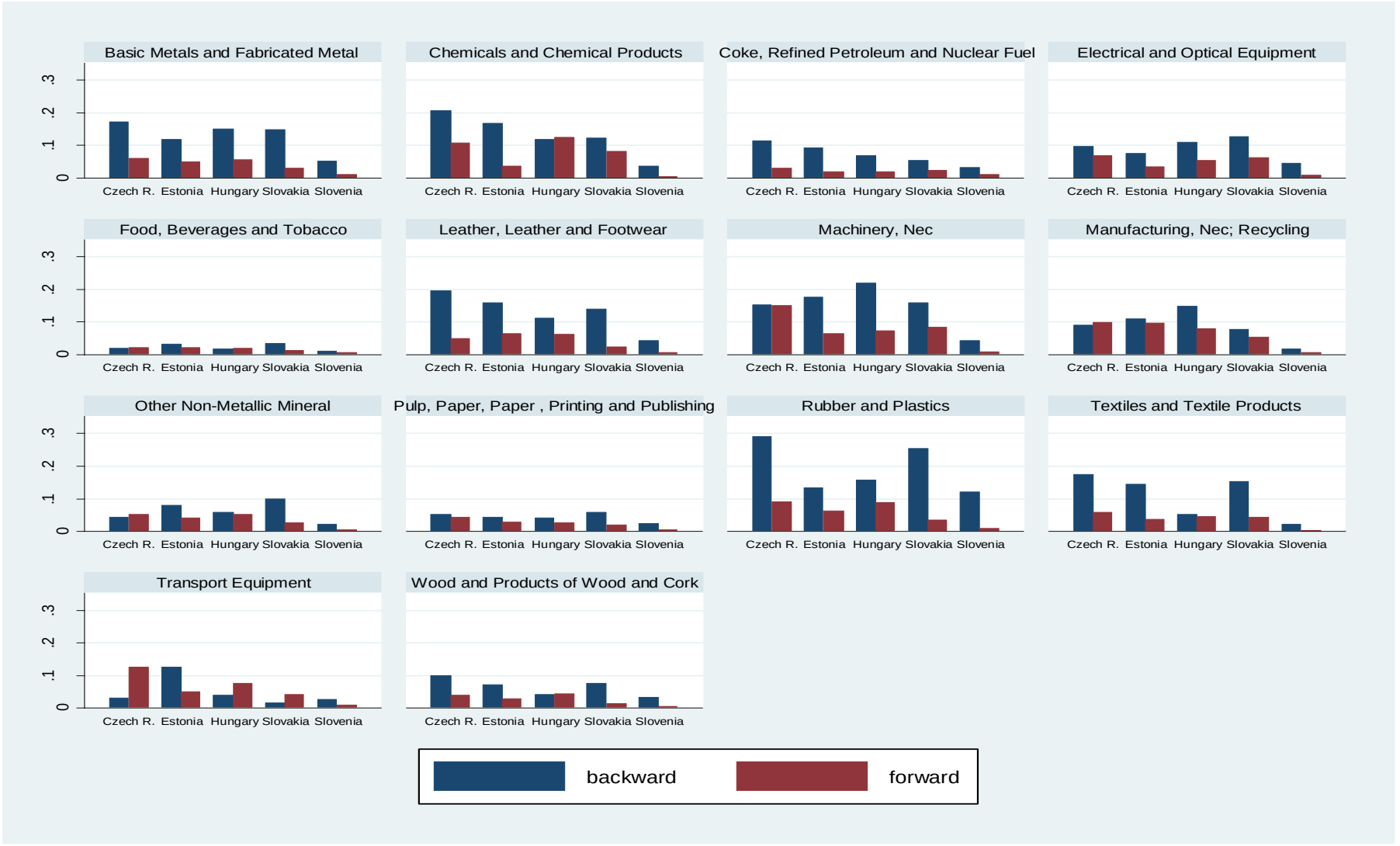

Figure A3. Average size of services backward and forward linkages across countries and manufacturing industries